

# NASA TECH BRIEF

## Ames Research Center



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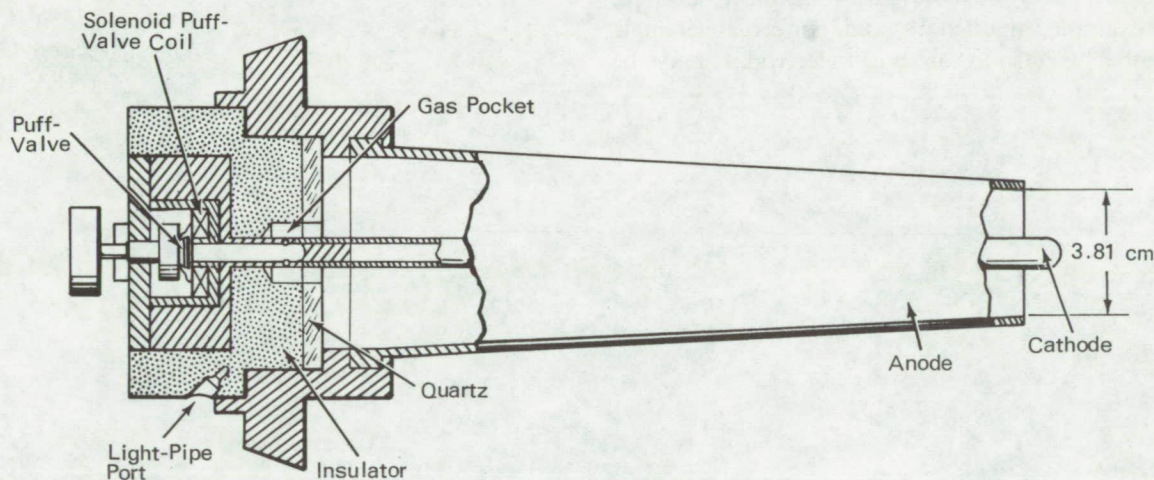
### Improved Plasma Accelerator

#### The problem:

A dense, high-energy plasma is required for the study of nuclear fusion reactions. Most existing plasma accelerators use strong shocks produced by

#### How it's done:

The plasma gun (see fig.) consists of the following components: a truncated conical shell (the anode); an axially concentric cylindrical or conical rod (the



magnetohydrodynamic techniques to accelerate the particles, but the particles can only travel as fast as the shock speed (about  $2 \times 10^7$  cm/sec). In addition, such accelerators either cannot focus plasmas, or can only provide a modicum of focusing as a result of the magnetic pinch effect.

#### The solution:

A converging, coaxial accelerator-electrode configuration is operated in a vacuum as a plasma gun. The plasma is formed by periodic injections of high-pressure gas that is ionized by electrical discharges. Acceleration is provided by a deflagration mode of discharge, and focusing is provided by the converging contours of the plasma gun.

cathode); an upstream insulator which provides a gas-tight seal and which electrically insulates the anode from the cathode; and a fast-acting solenoid valve which injects a controlled amount (puff) of gas into a small pocket located at the upstream end (large end) of the gun.

The gun is operated in a chamber evacuated to a pressure of  $10^{-7}$  torr. A charged capacitor bank is connected to the gun electrodes. When a gas puff is injected into the system, the electrical discharge is typically self-triggered, according to the Paschen curve for electrical breakdown. Alternatively, the electrical discharge may be triggered by a switching system which provides a suitable time delay after the gas puff has been injected. The resulting plasma

(continued overleaf)

is accelerated as a deflagration wave. In this mode of operation, the plasma particles are accelerated in a high-pressure region and are expelled into a low-pressure region, where a negligible number of collisions occur to impede their progress. This permits the plasma to travel faster than the shock-propagation velocity.

The pocket of gas at the upstream end of the gun supplies gas to the accelerating region for a relatively long period of time, and the ionization process continues until the bank of stored electrical energy is discharged. Since the direction of the acceleration force  $\vec{E} \times \vec{B}$  (where  $\vec{E}$  is the electrostatic field vector and  $\vec{B}$  is the induced magnetic field vector) can be controlled by the shape of the electrodes, focus or defocus of the plasma pulse is possible. In the illustrated focusing configuration, the accelerated plasma issues from the gun in a converging stream which has a focal point at some distance downstream.

#### Notes:

1. Different electrode configurations may be used. For example, the length and convergence angle of either electrode or both electrodes may be varied.

2. The plasma gun typically provides hydrogen or deuterium plasma velocities on the order of  $10^8$  cm/sec.
3. The plasma gun can be used for rocket propulsion. It characteristically provides a specific impulse of  $10^5$  sec at a thrust density of approximately  $100 \text{ kN/m}^2$ .
4. Requests for further information may be directed to:

Technology Utilization Officer  
Ames Research Center  
Moffett Field, California 94035  
Reference: TSP71-10454

#### Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to:

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